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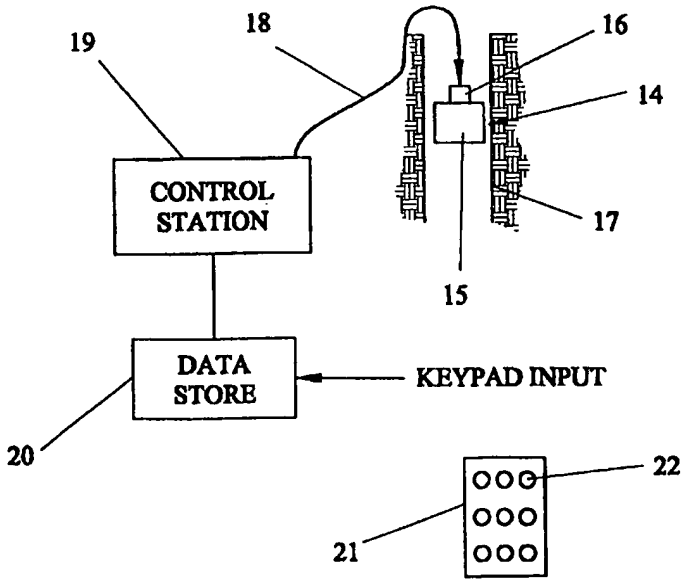
(54) Title: SETTING OF TIME DELAYS IN A SEQUENCE OF EXPLOSIVE DETONATIONS

(57) Abstract

An electrically operated rock blasting system for detonating a number of explosive charges (15), each located in a respective one of a series of spaced boreholes (12, 13) formed in a rock mass site, the system comprising: a control station (19) remote from the explosive charges and adapted to sequentially detonate the explosive charges; a data store (20) at the control station for receiving different types of site data, the site data having an influence on the time intervals between successive detonations, one such site data comprising the physical distance (d) separating the boreholes of successively detonated explosive charges; and, a data input device (21) for use by a site operator and having a memory store into which can be entered separate distance data between successive boreholes of the series, such data being convertible into corresponding time interval data to be set at the control station.



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SETTING OF TIME DELAYS IN A SEQUENCE OF EXPLOSIVE DETONATIONS

This invention is concerned generally with the setting of time delays in a sequence of explosive detonations.

In the explosive fragmentation of a rock mass in a mine, it is usual to form a row/ring of spaced bore holes into each of which an explosive charge can be located, and for each charge to have an associated detonator which can be remotely triggered into operation from a remote firing station. In order to maximise the efficiency of any particular detonation sequence of explosive charges, it is important to control the time intervals between each successive explosion. The desired time intervals may vary according to a number of factors, and including (a) the nature of the rock and (b) the spacing apart of the bore holes.

Detonations are usually triggered electrically from a remote firing point, and many different electronic control systems have been developed to enable, as far as possible, theoretically desired time intervals to be achieved in practice.

Some existing control systems are very sophisticated, including specially developed software programmes permitting an operator to enter input data dependent on site conditions, with a view to achieving desired time delays between successive detonations. However, despite the sophistication of the software, and the use of so called "electronic detonators", in practice it is difficult to achieve repeated blasting sequences of maximum efficiency. Deviation from desired time intervals results in lower efficiency of utilisation of the energy of the explosive charges, and production of larger proportions of unusable fragmented

material and dust, as well as creating increased ground vibrations.

As mentioned above, the hole to hole separation in one row of charges is one of the critical factors affecting desired time intervals, and also the separation between adjacent rows of boreholes, and it would be desirable to provide a simple means whereby an operator on site could easily input appropriate data into a memory store, as he moves from one borehole to another e.g. when loading each hole with its pack of explosive charge and associated detonator, and then to be able to transfer such data to a remote control station.

Accordingly, the present invention provides an electrically operated rock blasting system for detonating a number of explosive charges, each located in a respective one of a series of spaced boreholes formed in a rock mass site, the system comprising:

a control station remote from the explosive charges and adapted to sequentially detonate the explosive charges;

a data store at the control station for receiving different types of site data, the site data having an influence on the time intervals between successive detonations, one such site data comprising the physical distance separating the boreholes of successively detonated explosive charges; and,

a data input device for use by a site operator and having a memory store into which can be entered separate distance data between successive boreholes of the series, such data being convertible into corresponding time interval data to be set at the control station.

The electrically operated rock blasting system according to the invention has the advantage that the positions of the boreholes can be simply measured and stored by an operator as he/she moves from borehole to borehole. This data can then be simply transferred to the control station.

Preferably, the data input device comprises a global positioning system (GPS) which is used to locate the positions of the boreholes. The GPS system provides a reliable and accurate absolute measurement of each of the boreholes of the series and hence the distance between them. The operator is not required to make measurements of the distances between boreholes, merely to place the GPS system close to each borehole in turn (usually when the borehole is being loaded) and make a measurement of position.

Alternatively, the data input device can comprise a portable keypad, the keypad preferably comprising number keys representative of different distances. A site operator can carry such a keypad from one borehole to another e.g. during loading of the boreholes with the packs of explosive charges/detonators, and can enter borehole separation-distance data as the operator moves from one borehole of the series to another. A suitable input can easily be made by counting the number of paces involved in moving from one borehole to another or using some other convenient measure of length.

Preferably, the data input device converts the distance data automatically to time interval data for subsequent down loading into the data store at the control station.

Alternatively, the data input device can be adapted to down load the distance data to the date store, the data store

being pre-programmed to convert the distance data to time interval data to be set at the control station.

The rock mass site may be a quarry. Alternatively, the invention may also be applied to formation of a tunnel through a rock face, in which case the boreholes will be spaced apart along a ring. Preferably some suitable length measuring means is then used to measure the spacing apart between consecutive holes.

The invention therefore permits, by simple means, a site operator to be able to enter distance derived data into the control station, so that (after collating any other site dependent data), initiation of a sequence of detonations can take place at time intervals which approach, or come within close enough ranges to theoretically desirable time intervals for efficient utilisation of the explosive energy created by successive explosions in any particular site location.

The invention also contemplates use of an electronically controlled system, in which pre-programmed time delay intervals can be stored, and to allow operator- controlled modification of the time delays by inputting of distance-dependent data (between adjacent holes) which is converted to time delay modification of the programmed intervals.

A preferred embodiment of electrically operated rock blasting system according to the invention will now be described in detail, by way of example only, with reference to the accompanying drawing, in which:

Figure 1 is a schematic illustration of a particular rock mass site with which the rock blasting system according to the invention may be used; and,

Figure 2 is a block diagram illustration of the major component parts of a preferred embodiment of system according to the invention.

Shown in Figure 1 is a rock mass site 10, having a free face 11, and two rows of spaced boreholes 12 and 13. Into each borehole is introduced a detonation pack 14.

Shown in figure 2 is a detonation pack 14 comprising an explosive charge 15, and a detonator 16, the detonator 16 preferably being an electronic detonator. The detonation pack 14 is located at a suitable depth below the surface within a borehole 17 so ensuring maximum effectiveness of the explosive charge 15. The detonation pack 14 can be triggered or initiated into operation by a suitable signal along a line 18 from a control station 19.

The control station 19 is a remote firing station connected by lines 18 to a series of detonation packs 14 arranged in the boreholes 17 of rows 12 and 13. The control station 19 is arranged to be capable of initiating sequential detonation of the series of explosive charges 15 of the detonation packs.

A data store 20 is arranged at the control station 19 and serves to receive different types of site data having an influence on theoretically desirable time intervals between successive detonations. Critical site data which may be inputted includes the particular nature of the rock face to be fragmented, and further critical data is the physical distance separation between boreholes of successively triggered charges of explosives.

Figure 1 shows by reference d, a typical borehole separation distance between two successively triggered explosive charges.

The system of this embodiment of the invention further comprises a portable keypad 21, the keyboard having entry buttons 22, each representative of a particular measured distance between successive boreholes, for use by a site operator as he moves between successive boreholes of the series. The keypad 21 has a memory store into which can be entered separate distance data between successive boreholes, and which is convertible into corresponding time interval data to be set at the control station 19.

The distance data entered by the operator would be determined simply by pacing out the distance between successive bore holes, working on an average stride of about 3 feet or a metre, and then the appropriate button 22 on the keypad 21 would then be operated.

In a typical existing design of rock blasting system, there might be a 45 millisecond predetermined delay in detonation from one borehole to another, whereas by means of the invention it is possible to give some discretion to the field operator to enter quite simply distance measurements from hole to hole, in order to de-skill the operation, and allow time delays to be set by the control station which more closely approximate to theoretically desirable values.

The distance data entered (e.g. 5 metres), is then converted automatically to time interval data to be set at the control station 19. This conversion takes place within the portable keypad 21 by provision of suitable preprogramming of the keypad, and is subsequently downloaded into the data store 20 at the control station 19. When converting the distance data into time interval data the portable keypad takes into account other site critical data, for example the nature of the rock face to be fragmented. The size of the boreholes may also be taken into account; if the holes are of a restricted

nature and so require more delay time to effect the desired relief then the holes can be specified as greater than actual (or vice versa) to effect the most desired time interval.

In an alternative embodiment of a system according to the invention (not shown), the keypad 21 includes a barcode reader which is able to log required detonator firing sequences from individual detonators in each borehole, each being uniquely coded.

In a further embodiment of a system according to the invention (not shown), the distance data entered into the keypad may be downloaded into the data store 20, which is in turn preprogrammed to convert the distance data to time interval data.

The electrically operated rock blasting system according to the invention, as described above and shown schematically in the drawings, therefore provides, by simple means, for a site operator to be able to enter distance derived data into the control station, so that (after collating any other site dependent data) initiation of a sequence of detonations can take place at time intervals which approach, or come within close enough ranges to theoretically desirable time intervals between successive explosions in any particular site location, in order to achieve efficient utilization of the blasting energy.

Claims

1. An electrically operated rock blasting system for detonating a number of explosive charges, each located in a respective one of a series of spaced boreholes formed in a rock mass site, the system comprising:

a control station remote from the explosive charges and adapted to sequentially detonate the explosive charges;

a data store at the control station for receiving different types of site data, the site data having an influence on the time intervals between successive detonations, one such site data comprising the physical distance separating the boreholes of successively detonated explosive charges; and,

a data input device for use by a site operator and having a memory store into which can be entered separate distance data between successive boreholes of the series, such data being convertible into corresponding time interval data to be set at the control station.

2. An electrically operated rock blasting system as claimed in claim 1, wherein the data input device comprises a global positioning system (GPS) which is used to locate the position of the boreholes.

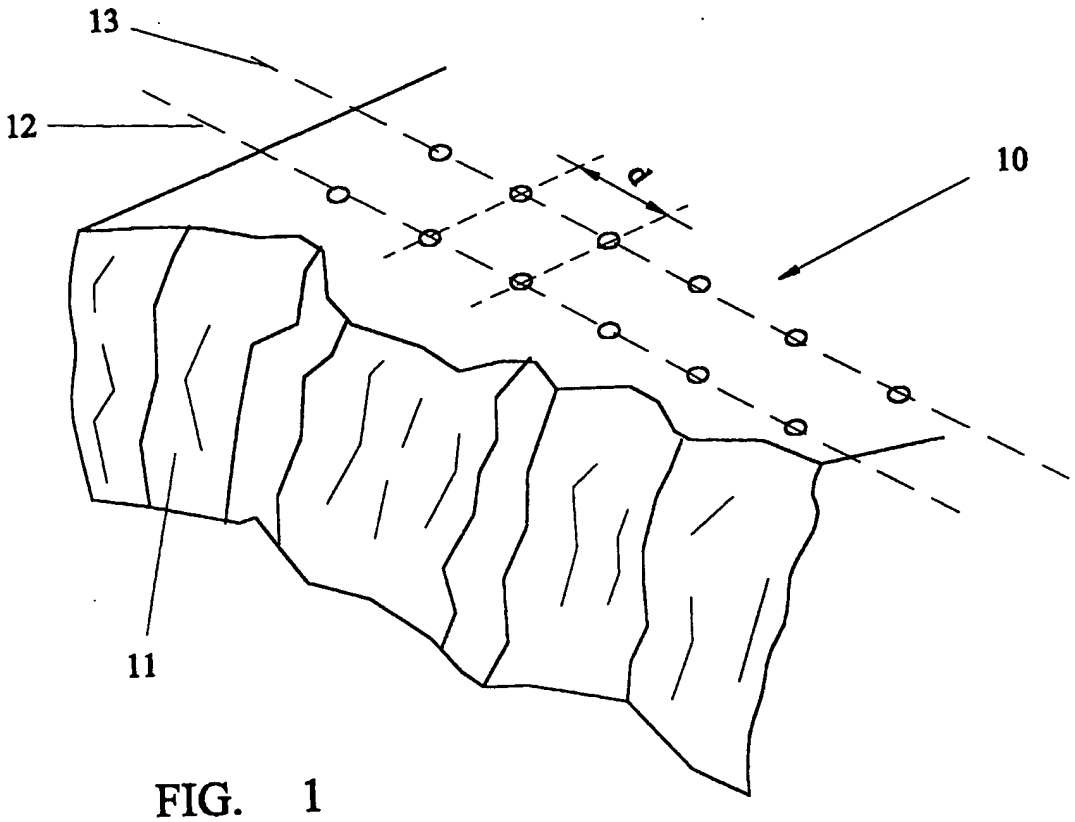
3. An electrically operated rock blasting system as claimed in claim 1, wherein the data input device comprises a portable keypad, the keypad preferably comprising number keys representative of different distances.

4. An electrically operated rock blasting system as claimed in an one of claims 1 to 3, wherein the data input device converts the distance data automatically to time interval data for subsequent down loading into the data store at the control station.

5. An electrically operated rock blasting system as claimed in any one of claims 1 to 3, wherein the data input device is adapted to download the distance data to the data store, the data store being pre-programmed to convert the distance data to time interval data to be set at the control station.

6. An electrically operated rock blasting system as claimed in any one of claims 1 to 5, wherein the rock mass site is a quarry.

7. An electrically operated rock blasting system as claimed in any one of claims 1 to 6, wherein the boreholes are spaced apart along a ring .


13
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d
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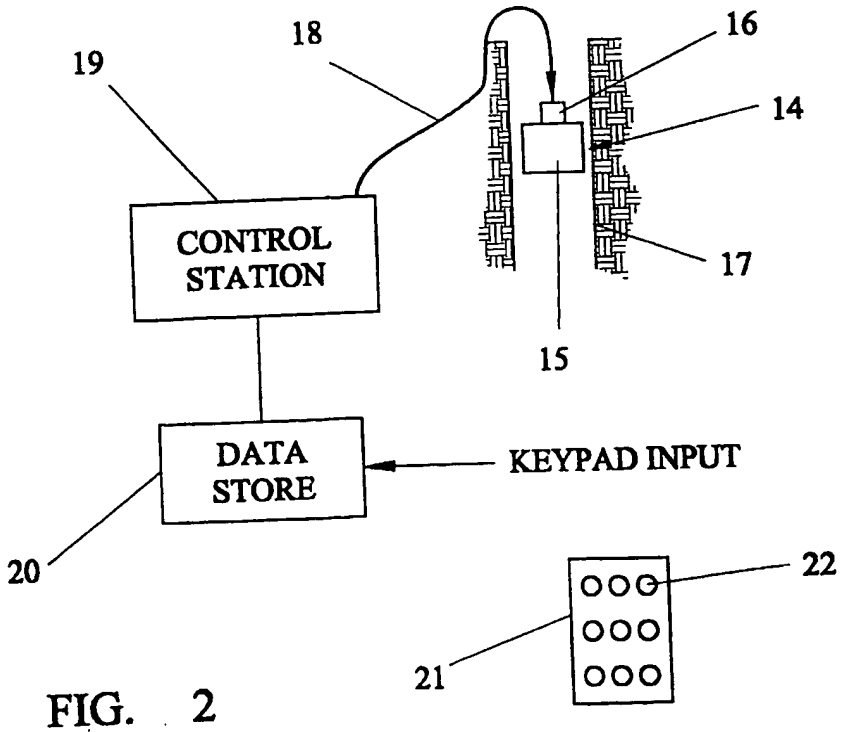
FIG. 1


18
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CONTROL STATION
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DATA STORE
KEYPAD INPUT
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22
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FIG. 2

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 99/02186

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F42D1/055

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F42D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 97 21067 A (EXPERT EXPLOSIVES ;BEUKES CHRISTO ANDRE (ZA); PATZ VIVIAN EDWARD () 12 June 1997 (1997-06-12) figures 9,10 page 11, line 1 - line 22 page 12, line 9 - line 23	1,3-7
A	---	2
Y	WO 96 16311 A (EXPLOSIVE DEV LTD ;SHANN PETER CHRISTIAN (GB)) 30 May 1996 (1996-05-30) abstract; claim 14; figure 1 page 3, paragraph 6 page 3, last paragraph page 6, paragraph 4 -page 7, paragraph 3	1,3-7

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
P,X	EP 0 897 098 A (SMI TECHNOLOGY PTY LIMITED) 17 February 1999 (1999-02-17) abstract; figures column 5, line 44 -column 7, line 51	1-7

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Information on patent family members

Int. Jonal Application No
PCT/GB 99/02186

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9721067 A	12-06-1997	AU 1036897 A	27-06-1997
		CA 2241231 A	12-06-1997
		CN 1217784 A	26-05-1999
		DE 19681674 T	03-12-1998
		EP 0879393 A	25-11-1998
WO 9616311 A	30-05-1996	AT 176046 T	15-02-1999
		AU 688154 B	05-03-1998
		AU 3852895 A	17-06-1996
		BR 9509726 A	21-10-1997
		CA 2204282 A	30-05-1996
		DE 69507512 D	04-03-1999
		DE 69507512 T	12-08-1999
		EP 0793799 A	10-09-1997
		ES 2126329 T	16-03-1999
		US 5894103 A	13-04-1999
		ZA 9509796 A	29-05-1996
EP 0897098 A	17-02-1999	AU 7990298 A	25-02-1999
		CA 2245026 A	13-02-1999